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FINAL REPORT

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EVT 47-87-5

MIL-STD-1660 Tests FOR PA116 Containers on Standard 40- By 44-Inch Metal Pallets with Fork Tine Safety Bars

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The U.S. Army Defense Ammunition Center and School (USADACS), Evaluation Division (SMCAC-DEV), was tasked by the Office of the Project Manager for Ammunition Logistics (PM-AMMOLOG), AMCPM-AL, Picatinny Arsenal, NJ to evaluate a suggestion from the field to incorporate fork tine safety bars on all standard metal pallets for safer material handling operations. This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted.

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Evaluation Division
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REPORT NO. EVT 47-87-5

MIL-STD-1660 TESTS FOR PA116 CONTAINERS ON STANDARD 40- BY 44-INCH METAL PALLETS WITH FORK TINE SAFETY BARS

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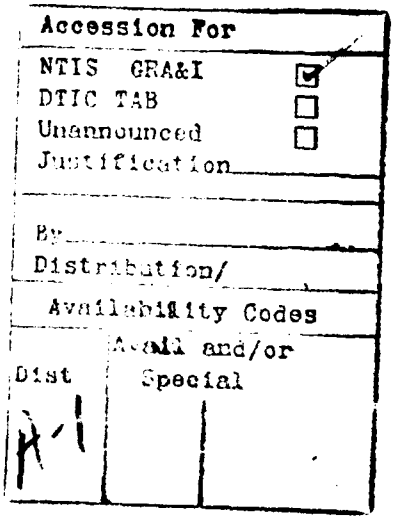
PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School, Evaluation Division, was tasked by PM-AMMOLOG, AMCPM-AL, to evaluate a suggestion from the field to incorporate fork tine safetv bars on all standard metal pallets for safer material handling operations. These safetv bars were intended to reduce the risk of pallets tipping off the fork tines during handling bv inexperienced operators.

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMMCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this test was to assess the feasibilitv of fork tine safetv bars on four-way entry metal pallets as well as any beneficial or adverse effect these bars have on the standard metal pallets.



PART 2

ATTENDEES

William R. Meyer
Test Engineer
DSN 585-8090
Comm 815-273-8090

U.S. Army Defense Ammunition Center
and School
ATTN: SMCAC-DEV
Savanna, IL 61074-9639

Laura Fieffer
Industrial Engineer
DSN 585-8075
Comm 815-273-8075

U.S. Army Defense Ammunition Center
and School
ATTN: SMCAC-DEO
Savanna, IL 61074-9639

PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identified nine steps that a unitized load must undergo if it is to be considered acceptable. The five tests that were conducted on the test pallets are summarized below.

A. STACKING TESTS. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16 feet high, for a period of one hour. This stacking load is simulated by subjecting the unit load to a compression weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner: The unit load weight is divided by the unit load height in inches and multiplied by 192. The resulting number is the equivalent compressive force of a 16-foot-high load.

B. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles per second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle or a platform acceleration achieves 1 $\pm$ 0.1 G's. Midway into the testing period the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours if the specimen is tested in one position; and, three hours for more than one position.

C. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4 1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
600 lbs.	72 inches	36 inches
3,000 lbs.	no limit	24 inches
no limit	no limit	12 inches

D. SLING COMPATIBILITY TEST. Unit loads utilizing special design for nonstandard pallets shall be lifted, slung, lowered, and otherwise handled as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when the load is suspended shall be cause for rejection of the unit load.

E. IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least 2 inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4 by 4 timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet per second.

PART 4

TEST EQUIPMENT

A. TEST PALLET

1. Drawing	AC200000A31
2. Width:	40 inches
3. Length:	44 1/2 inches
4. Height:	52 1/2 inches
5. Weight:	2,475 pounds

B. COMPRESSION TESTER.

1. Manufacturer:	Ormond Manufacturing
2. Platform:	60 inches by 60 inches
3. Compression Limit:	50,000 pounds
4. Tension Limit:	50,000 pounds

C. TRANSPORTATION SIMULATOR.

1. Manufacturer:	Gaynes Laboratory
2. Capacity:	6,000-pound pallet
3. Displacement:	1/2-inch Amplitude
4. Speed:	50 to 400 rpm
5. Platform:	5- by 8-foot

D. INCLINED RAMP.

1. Manufacturer:	Conbur Incline
2. Type:	Impact Tester
3. Grade:	10 percent Incline
4. Length:	12-foot Incline

PART 5

TEST RESULTS

ENGINEERING TESTS

Vertical lift tests were conducted to determine the operating window in which safety bars could be used. With 22 inches being the center of gravity (CG) of the pallet, the fork tines were retracted in 2-inch increments until damage to the pallet and/or safety bars occurred. No damage was noted at 18 inches, but at 16 inches permanent deformation occurred to the safety bars and pallet deck under static load conditions. The test was terminated. (Photo No.1). The operating window for fork tine safety bars was therefore established at 4 inches beyond the CG of the pallet. At the conclusion of this test, during material handling operations, one fork tine inadvertently caught under the safety bar causing permanent deformation to the safety bar upward. (Photo No. 2).

MIL-STD 1660 TESTS

A. STACKING TEST.

During the one hour compression test no damage was noted with the use of the safety bar.

B. REPETITIVE SHOCK TEST.

During the three hours of low frequency vibration testing the pallet accumulated 12 weld/metal cracks or failures. (Photos 3, 4, 5). This was due, in part, to the permanent deformation to the pallet deck during engineering tests. Under prestressed conditions and distortion to the pallet deck, non-uniform loading was experienced during the vibration test, resulting in metal/weld cracks and failures.

C. EDGEWISE ROTATIONAL DROP TEST.

During this test weld/metal cracking continued after impacts to the skids.

More damage was noted to this pallet than typically seen in other standard pallets tested. This was due, in part, to the weakened condition of the pallet after vibration testing.

D. IMPACT TEST.

During this test no additional damage was noted, with the pallet rotated clockwise after each impact.

E. SLING TEST.

During this test no additional damage was noted.

PART 6

CONCLUSION & RECOMMENDATION

A. CONCLUSION

The pallet, as tested, did not pass MIL-STD-1660, Design Criteria for Palletized Ammunition Unit Loads due to excessive weld/metal cracks and failures, as well as nonstackability from permanent deformation of the safety bars in the downward direction. Other concerns regarding the use of safety bars include:

1. The marginal effectiveness at improving the pallet handling safety, about 4 inches beyond the CG, under static conditions, under dynamic loading, this would be less.

2. Any damage downward will result in a nonstackability.

3. Any damage upward results in difficulty in entrance and greater operator skill.

4. Damage to the pallet deck is increased resulting in weld/metal prestressing and premature failure.

B. RECOMMENDATION.

Disapprove the suggestion for an engineering change proposal incorporating safety bars into standard metal pallet design.

PART 7

PHOTOGRAPHS

DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Photo No. 1 This photo shows permanent deformation to the pallet deck after forklifting tests. Note: Safety bars below this deformation are bent downward.

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Photo No. 2	This photo shows permanent deformation to safety bar after forklift tine entered under the safety bar.	

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Photo No. 3 This photo shows typical metal cracks experienced during this test.

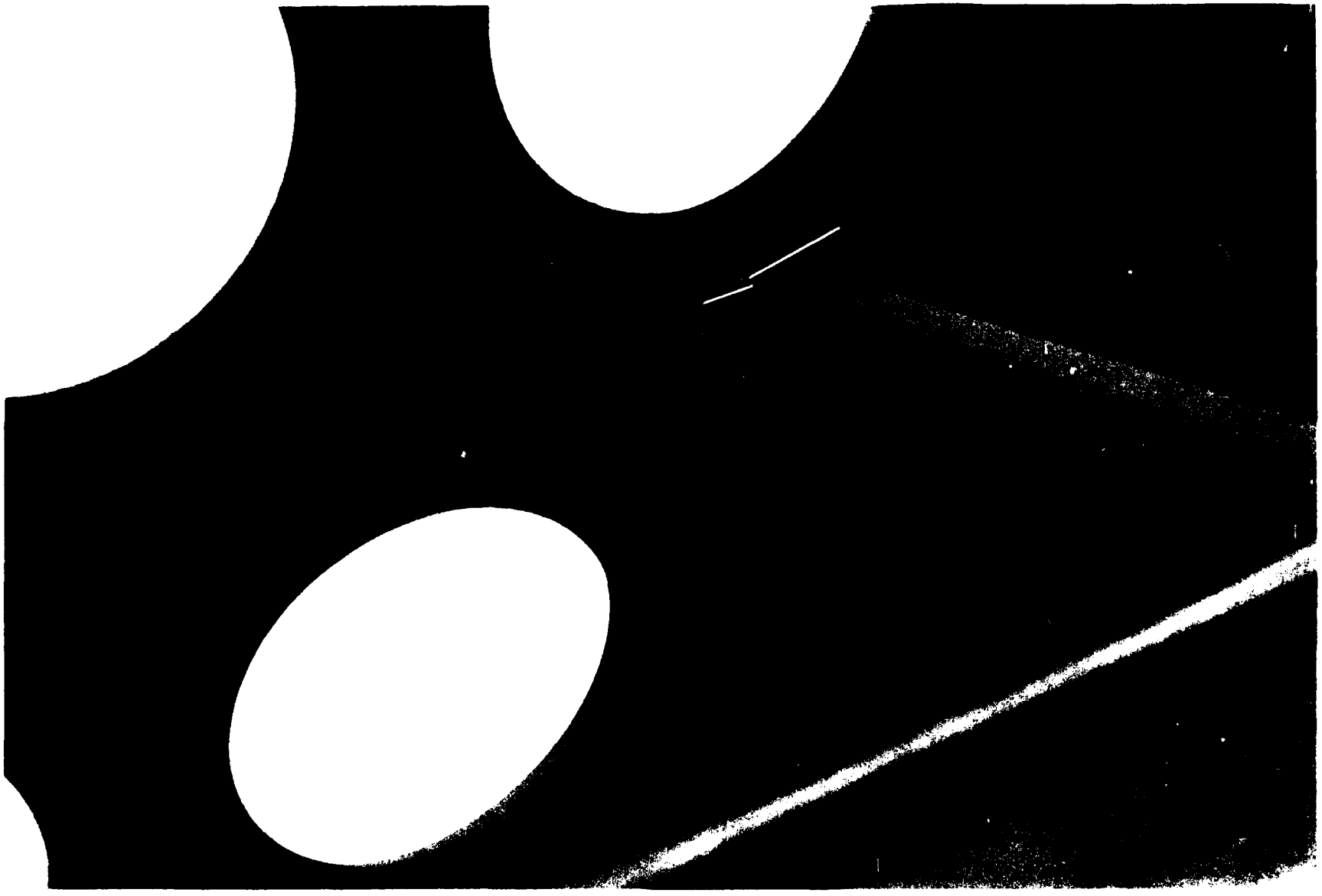

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Photo No. 4 This photo shows typical metal cracks experienced during this test.

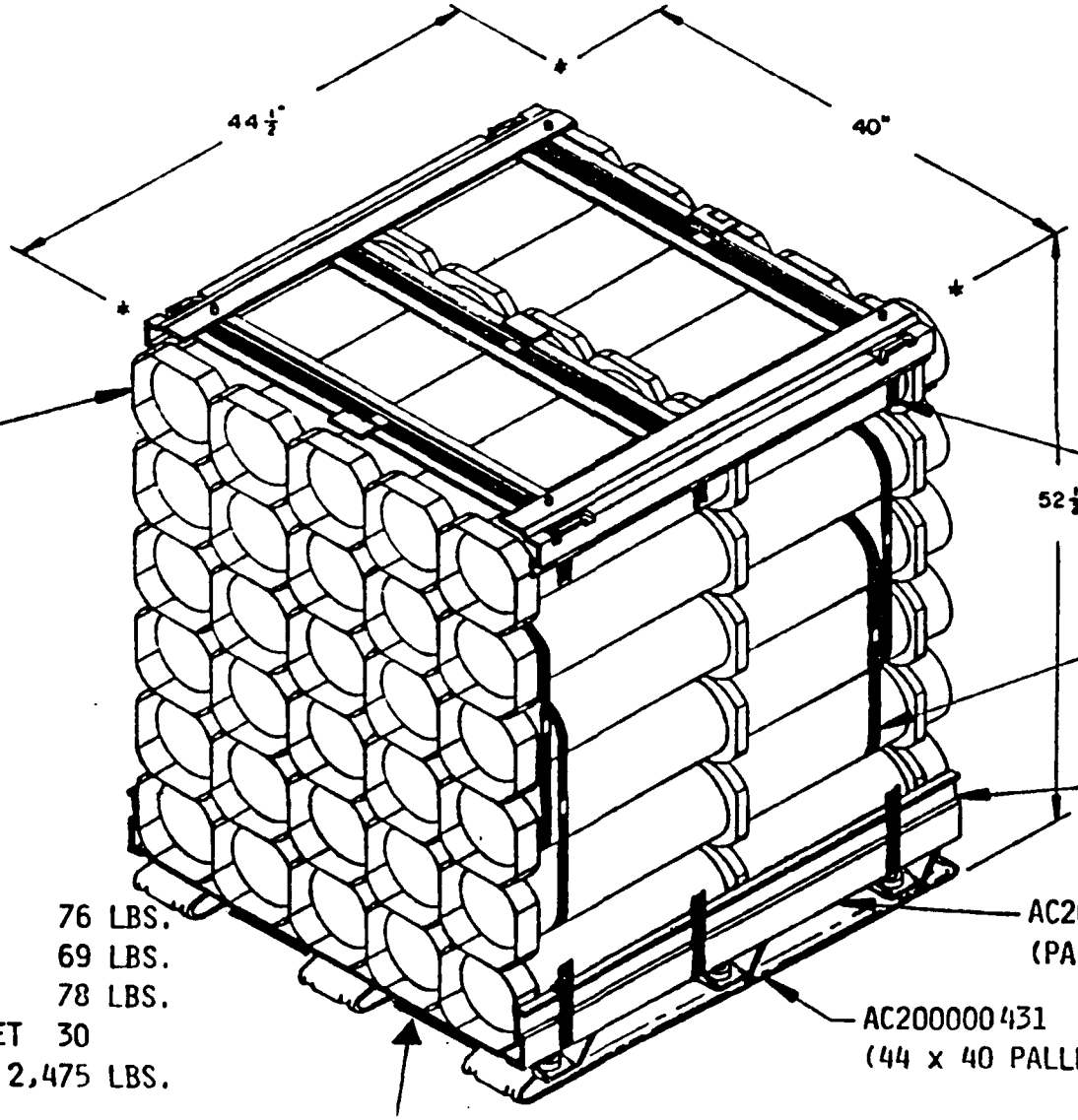
DEFENSE AMMUNITION CENTER AND SCHOOL- SAVANNA, IL

Photo No. 5 This photo shows typical metal cracks experienced during this test.

PART 8

DRAWING

PALLETIZED UNIT LOAD FOR THE PA116 CONTAINER



(ESTIMATES)

PALLET WT	76 LBS.
ADAPTER WT	69 LBS.
UNIT PACK WT	78 LBS.
UNIT PACK/PALLET	30
UNIT LOAD WT	2,475 LBS.

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